Astrophysics Practice Questions

1. Natalie measures the mass and speed of a glider. The percentage uncertainty in her measurement of the mass is 3% and in the measurement of the speed is 10%. Her calculated value of the kinetic energy of the glider will have an uncertainty of

A. 30%.

B. 23%.

C. 13%.

D. 10%.

(1)

2. Which **one** of the following lists a fundamental unit and a derived unit?

A.	ampere	second
B.	coulomb	kilogram
C.	coulomb	newton
D.	metre	kilogram

(1)

3. A student measures the current in a resistor as 677 mA for a potential difference of 3.6 V. A calculator shows the resistance of the resistor to be 5.3175775 Ω. Which **one** of the following gives the resistance to an appropriate number of significant figures?

A. 5.3 Ω

B. 5.32 Ω

C. 5.318 Ω

D. 5.31765775 Ω

(1)

4. Which **one** of the following is a scalar quantity?

A. Pressure

B. Impulse

C. Magnetic field strength

D. Weight

(1)

5. The frequency f of an oscillating system is given by

$$f = \frac{1}{2\pi}\sqrt{\frac{g}{l}}$$

where g and π are constants.

The frequency f is measured for different values of l and a graph is plotted.

Which **one** of the following will produce a straight-line graph?

	***x*-axis**	***y*-axis**
A.	$\sqrt{f}$	$\sqrt{l}$
B.	$\sqrt{f}$	l
C.	f^2	$\frac{1}{l}$
D.	f^2	$\sqrt{l}$

(1)

6. A particle is moving in a circular path of radius r. The time taken for one complete revolution is T. The acceleration a of the particle is given by the expression

$$a = \frac{4\pi^2 r}{T^2}.$$

Which of the following graphs would produce a straight-line?

A. a against T

B. a against T^2

C. a against $\frac{1}{T}$

D. a against $\frac{1}{T^2}$

(1)

7. Sub-multiples of units may be expressed using a prefix. Which **one** of the following lists the prefixes in **decreasing** order of magnitude?

A.	centi-	micro-	milli-	nano-
B.	milli-	centi-	nano-	micro-
C.	centi-	milli-	micro-	nano-
D.	milli-	micro-	centi-	nano-

(1)

8. An elephant has a life expectancy of 60 years. Which of the following gives the order of magnitude of this lifetime?

A. 10^{11}s

B. 10^{9}s

C. 10^{7}s

D. 10^{5}s

(1)

9. The order of magnitude of the weight of an apple is

A. 10^{-4} N.

B. 10^{-2} N.

C. 1 N.

D. 10^{2} N.

(1)

10. The density of a metal cube is given by the expression $\rho = \frac{M}{V}$ where M is the mass and V is the volume of the cube. The percentage uncertainties in M and V are as shown below.

M	12%
V	4.0%

The percentage uncertainty in the calculated value of the density is

A. 3.0%.

B. 8.0%.

C. 16%.

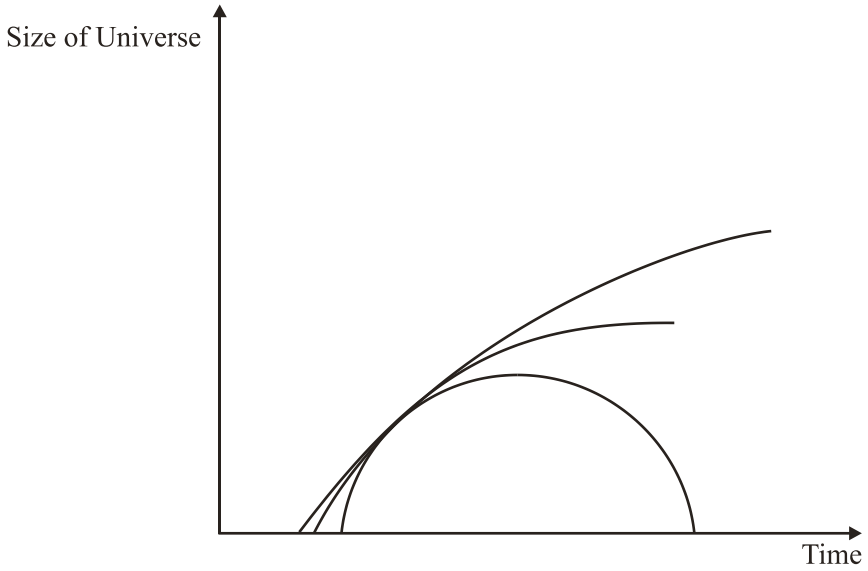
D. 48%.

(1)

11. This question is about the possible evolution of the Universe.

The diagram below is a sketch graph that shows three possible ways in which the size of the Universe might change with time.

Depending on which way the size of the Universe changes with time, the Universe is referred to either being *open* or *flat* or *closed*.



(a) On the diagram, identify each type of Universe.

(3)

(b) Complete the table below to show how the mean density ρ of each type of Universe is related to the critical density ρ_0.

Type of Universe	**Relation between ρ and ρ_0**
Open	
Flat	
Closed	

(3)
(Total 6 marks)

12. This question is about Cepheid variables.

(a) Define

(i) *luminosity*.

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(1)

(ii) *apparent brightness*.

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(1)

(b) State the mechanism for the variation in the luminosity of the Cepheid variable.

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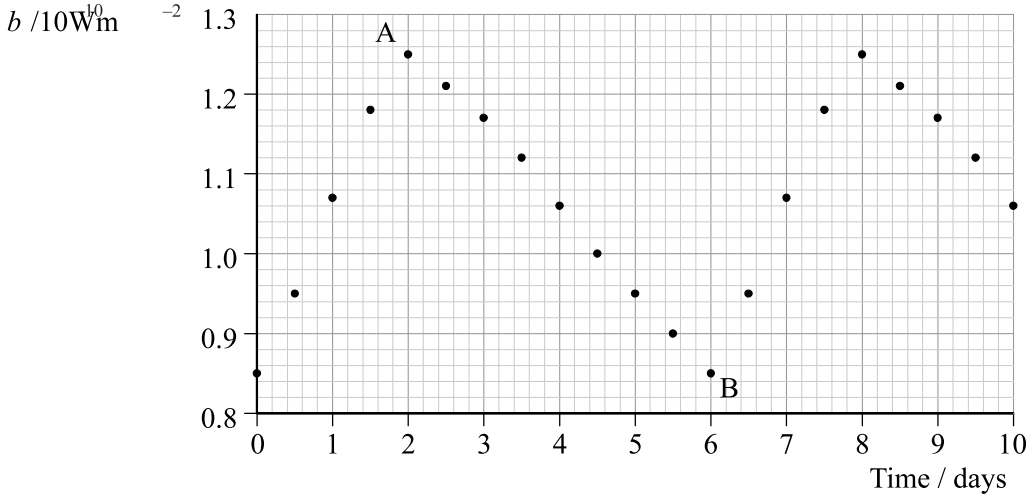
(1)

The variation with time t, of the apparent brightness b, of a Cepheid variable is shown below.



Two points in the cycle of the star have been marked A and B.

(c) (i) Assuming that the surface temperature of the star stays constant, deduce whether the star has a larger radius after two days or after six days.

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(2)

(ii) Explain the importance of Cepheid variables for estimating distances to galaxies.

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(3)

(d) (i) The maximum luminosity of this Cepheid variable is 7.2×10^{29} W. Use data from the graph to determine the distance of the Cepheid variable.

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(3)

(ii) Cepheids are sometimes referred to as "standard candles". Explain what is meant by this.

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(2)
(Total 13 marks)

13. This question is about the Big Bang model.

(a) Describe what is meant by *cosmic background radiation*.

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(2)

(b) Explain how cosmic background radiation is evidence in support of the Big Bang model of the universe.

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(2)

(c) State **one** other piece of evidence in support of the Big Bang model.

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(1)

(d) A student makes the statement that "*as a result of the Big Bang, the universe is expanding into a vacuum*". Discuss whether the student's statement is correct.

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(2)
(Total 7 marks)

14. This question is about the properties of the star Arcturus.

The following data is for the star Arcturus.

Distance from Earth / m	Apparent magnitude	Absolute magnitude	Spectral type	Luminosity / W
3.39×10^{17}	–0.1	–0.3	K	3.8×10^{28}

(a) Explain the difference between *apparent magnitude* and *absolute magnitude*.

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(2)

(b) State and explain, with reference to the data, whether Arcturus would be visible without the aid of a telescope on a clear night.

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(1)

Techniques for determining stellar distances include the use of stellar parallax, spectroscopic parallax and Cepheid variables.

(c) (i) Calculate the distance, in pc, of Arcturus from the Earth.

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(1)

(ii) State and explain which technique would be most suitable for determining the distance to Arcturus.

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(2)

(iii) Outline the method you have chosen in your answer to (c)(ii).

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(4)

(d) State how it may be deduced from the data that the surface temperature of Arcturus is lower than that of the Sun.

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(2)

The temperature of Arcturus is 4000 K.

(e) Calculate

(i) the surface area of Arcturus.

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(2)

(ii) the radius of Arcturus.

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(2)

(iii) the wavelength at which the light from Arcturus has its maximum intensity.

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(2)

(f) Using your answers to (e) deduce the stellar type to which Arcturus belongs.

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(2)

(Total 20 marks)

15. The question is about stellar radiation and the star Betelgeuse.

(a) Explain the term *black-body radiation*.

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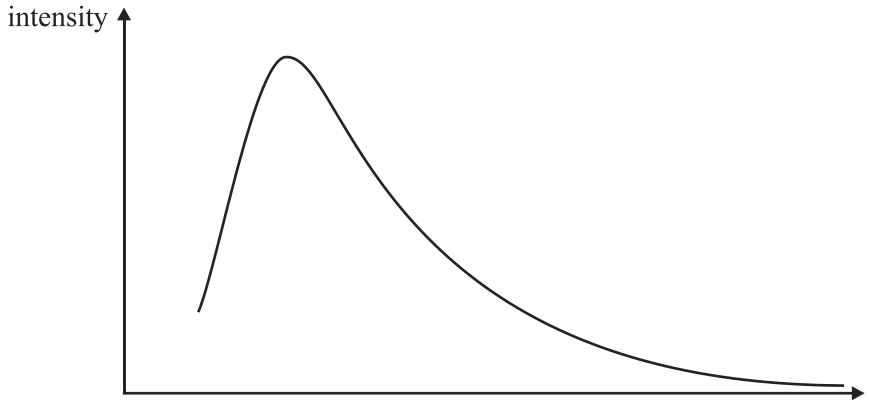
(1)

The diagram below is a sketch graph of the black-body radiation spectrum of a certain star.



(b) Label the *x*-axis of the graph.

(1)

(c) On the graph, sketch the black-body radiation spectrum of a star that has a lower surface temperature and lower apparent brightness than this star.

(2)

The star Betelgeuse in the Orion constellation emits black-body radiation that has a maximum intensity at a wavelength of 0.97 μm.

(d) Deduce that the surface temperature of Betelgeuse is about 3000 K.

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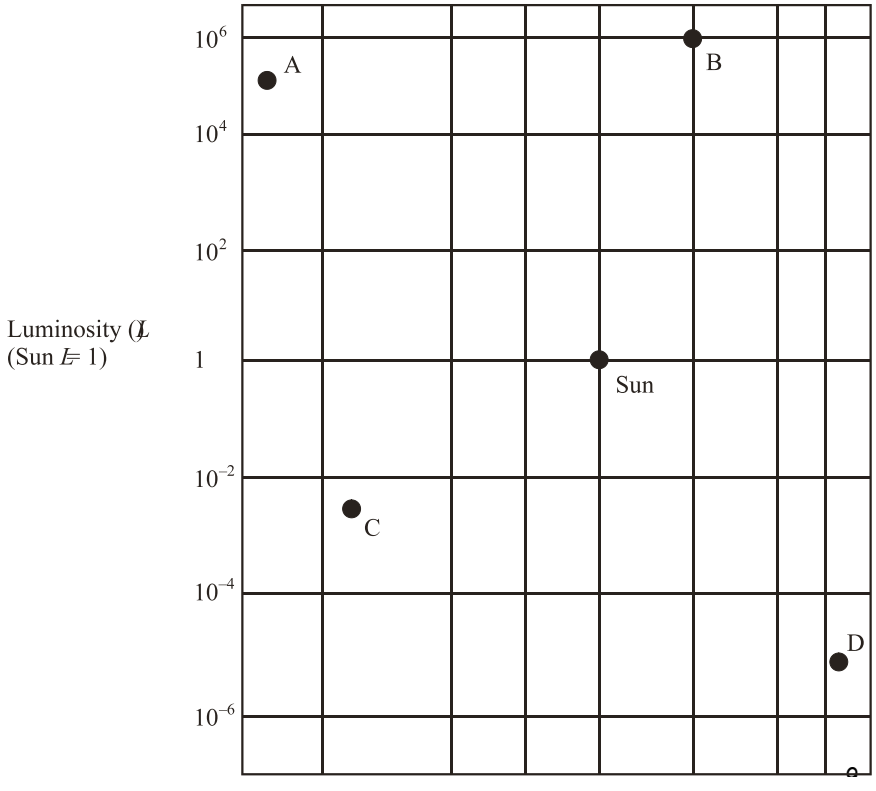
(1)

(Total 5 marks)

16. This question is about the nature of certain stars on the Hertzsprung-Russell diagram and determining stellar distance. The diagram below shows the grid of a Hertzsprung-Russell (H-R) diagram on which the positions of the Sun and four other stars A, B, C and D are shown.



(a) State an alternative labelling of the axes,

(i) *x*-axis

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(1)

(ii) *y*-axis

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(1)

(b) Complete the table below.

Star	Type of star
A	
B	
C	
D	

(4)

(c) Explain, using information from the H-R diagram, and without making any calculations, how astronomers can deduce that star **B** is larger than star **A**.

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(3)

(d) Using the following data and information from the H-R diagram, show that star **B** is at a distance of about 700 pc from Earth.

Apparent visual brightness of the Sun $= 1.4 \times 10^{3}$ W m^{-2}
Apparent visual brightness of star B $= 7.0 \times 10^{-8}$ W m^{-2}
Mean distance of the Sun from Earth $= 1.0$ AU
1 parsec $= 2.1 \times 10^{5}$ AU

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(4)

(e) Explain why the distance of star **B** from Earth cannot be determined by the method of stellar parallax.

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(1)
(Total 14 marks)